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EFFECTS OF INCOMPLETE TRAVEL INFORMATION ON THE CHOICE BEHAVIOR OF AIRLINE PASSENGERS

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Abstract: This paper explored the impacts of incomplete travel information on airline passengers' choice behavior in practically. We specified three different kinds of utility function to incorporate the effects of incomplete information into choice model and used binary logit model and random coefficient logit model (RCL) to estimate, based on the data collected from a stated choice experiment. From the estimation results, it can be found that the attributes with incomplete information, included airline safety and Consumers' word-of-mouth, were less important than the variables with complete information, such as flight frequency as well as ticket price, after considering the effect of the taste variants between individuals. Further, it was also found that passengers' backgrounds interacted with the incomplete information attributes would significantly have negative impacts on their choices. The higher the passengers' income as well as education, the more negative impacts of incomplete information on their choice behavior.

Key Words: incomplete information, binary logit model, random coefficient logit model, stated choice experiment.

1. INTRODUCTION

Uncertainty is always an unavoidable problem or situation when customer makes their consumption decisions in daily life. Especially when a customer faces a situation in which the information is incomplete, and he/she still has to make a decision. When such kind of situation occurs, the decision may not satisfy consumer's needs, based on the principle of utility maximization. However, it truly happens in the real world and there is no exception when it comes to the choice decision of airline services.

In general cases, prior to a traveler arrange a flight trip, he would like to know which airline he can choose? Which airline provides the best services? What are the flight frequencies? How much money he/she should pay for the trip? Moreover, the traveler would also like to know the safety records of the airline he will take (such as the information about the ages of airplane)? Unfortunately, airline passengers will never know clearly all the information what we have discussed above. Even if the passengers are frequent flyers, they seldom know, for example, any kind of safety information regarding to the airplane's ages. It means that passengers own less information than the airline service provider, and it might lead to the situation of moral hazards (Sheehan and Hoy, 1999; Grabner-Kraeuter, 2002; Erdem, *et. al*., 2002).

One example might probably explain the phenomenon of information asymmetry and lead to disaster outcome. On Feb 25, 2001, a passenger airliner crashed into Taiwan Strait near Peng-Hu, an island located at the southwestern part of Taiwan, which resulted in the death of over 200 lives including passengers and crewmembers. Through investigation, it was found that the airline might be responsible for a dispatching operation mistake, since the airplane was 22 years old, and it was going to be decommissioned from their fleet and transacted to another carrier. Although there was no direct evident to validity the relationship between ages of airplane and safety, one issue still raised was that whether the airline should public the maintenance records as well as the ages of airplane to passengers or not? Passengers could choose a flight that benefits them most (and take less risks) before start if they know the complete travel information of airlines.

While in past studies, it is assumed that people make their travel choice decision under the scenario of complete pre-trip information, especially in the studies of applying stated preference method, even if the choice set contained a new alternative that does not exist in the presence market, i.e. new high-speed rail or new constructed transportation facility (Preston, 1991; Fowkes and Preston, 1991; Gunn, *et al*., 1992, etc.). But in the field of consumer behavior study, some reports indicated that if consumers don't know the information very much, their preference would show intransitivity (Kivetz and Simonson, 2000). It means that consumers' choice behavior might not be the same as usual under the scenario of incomplete information.

Thusly, the major purpose of this study was to analyze the passenger's choice behavior under the scenario of incomplete travel information and find out the significant variables that affected the decisions of passengers through the choice model analysis. This paper proposed a stated choice experiment to simulate the scenario of incomplete travel information to airline passengers. Next, different logit model, included binary logit model as well as random coefficient logit model, were estimated based on the choice data from the SP experiment and the various specification of utility function to catch the effect of incomplete information on passengers' choice behavior. The findings of this study would demonstrate the importance of the complete travel information on passengers' choice. It is expected that airline services industry should public information actively as much as they can to decrease the phenomenon of information asymmetry in air transportation market.

The remainder of the paper is organized as follows. The next section presents the discussions of past researches. Section 3 introduces our stated choice experiment and the utility function specification. In Section 4, the proposed methodology is illustrated in a case study. Finally, we conclude the paper by summering our findings and presenting possible future research directions.

2. LITERATURE REVIEW

There had been a lot of academic researchers that devoted themselves into the study of air travel choice behavior. The findings of all these researches reported that time factor, included travel time, frequency as well as expected arrival time, and price as two major important variables on passengers' choice behavior. Of course, some of these significant findings were caught from using stated preference model.

For example, Lu (1999) used stated preference model to analyze the choice behavior of

Taiwan airline passengers, he found that the ticket price, early arrival time, late arrival time as well as other service factors were the significant variables influencing the choice decision of Taiwan passengers. Yoo and Ashford (1996) also found that ticket price, travel time, flight frequency and airline nationality affected air passengers' choice significantly through their responses of stated preference. In addition, Lu and Tsai (2004) discussed the effects of enlarged seating room on passengers' choice based on stated choice data and indicated that ticket price was also a significant variable. All such researches had at least one common characteristic – provide a scenario of complete travel information.

But in Kivetz and Simonson's (2000) work, it successfully demonstrated the impacts of incomplete information on consumer behavior. The choice scenarios they designed missed one attribute's information in each alternative with intensive attention. Therefore, consumers faced an incomplete information choice scenario – for each pair of alternatives, there is one dimension with full information and the others dimensions on which the information is available for only one alternative. Table 1 illustrated an example demonstrated in the study of Kivetz and Simonson (2000).

Table 1. An Example Demonstrated in The Study of Kivetz and Simonson (2000)

	Health Club A	Health Club B	Health Club C
Annual membership fee (range: $200-$500)	$230/year	$420/year	(Information unavailable)
Variety of exercise machines (range: poor-excellent)	Averages	(Information unavailable)	Very good
Driving time to health club (range: 5-30 minutes)	(Information unavailable)	6 minutes	18 minutes

Source: Kivetz and Simonson (2000).

For illustration, in Table 1, for the alternatives of Club A and Club B, they have one common attribute with full information, but two unique attributes on which the information is available for only one alternative. The major finding of Kivetz and Simonson's (2000) work is that consumer's preference of those alternatives would not be consistent with the rule of transitivity. In other words, under the scenario of incomplete information, Club A is preferred to Club B, Club B is preferred to Club C, but Club C is preferred to Club A. By the way, Kivetz and Simonson (2000) also found that consumers would overweigh the common attribute compared with the unique attribute. While in Kivetz and Simonson's (2000) study, they didn't use any econometrical model to analyze the behavior of consumers under the scenario of incomplete information.

Lu and Chiang (2004) applied the concept proposed by Kivetz and Simonson (2000) to study travelers' choice over airline and high-speed rail (HSR). They simulated the stated choice scenarios of missing the information of access time to HSR station only or missing both information of access time to HSR station as well as ticket price of HSR. Then they used logit model to analyze the choice data and found that the less the travel information was, the more significant negative impact on travelers' choice was. Besides, their study also concluded that passengers weigh more importance on common attributes.

In addition, Urbany, *et al*. (1989) studied the relationship of information search and the uncertainty of consumption, they used shopping time, the number of shops visited, asking the viewpoints of others consumers and referring the consumer reports, etc. for measuring the information search behavior of consumers. The results of their study implied that consumers would devote themselves to search any consumption information to decrease the uncertainty of consumption.

Finally, some reports also concluded that while people making the choice decision under incomplete information scenario would refer the external signaling, such as the brand name of the services or products or consumers' reports as well as other consumers' viewpoints (Erdem, *et al.*, 2002; Grabner-Kraeuter, 2002). In other words, people will trust the brand (corperate) images or recommendations, especially when they face the credence goods (Lovelock and Wright, 2002).

Summing-up the discussions above, it may be complex to understand the choice behavior of consumers under the situation of incomplete information. According to the finding of some related studies, people would weigh more importance on the common attributes, i.e. with complete information, of alternatives than on the unique attributes. Hence, it may lead to ignore the importance of the attributes with incomplete information. For this study, airline safety in terms of the ages of airplane is truly a significant as well as important factor, however, it is not easy to observe that effect from revealed choice behavior of passengers because there is no such information in the market of air transportation. As a result, this study developed a stated choice experiment to present the scenario of incomplete travel information to airline passengers and disclosed the importance of the attributes with incomplete information on passengers' choice decision.

3. METHOD AND STUDY DESIGN

3.1 Stated Choice Experiment

In order to measure the effects of missing travel information on airline passengers' choice behavior, we proposed a stated choice experiment. The experiment included two airline alternatives and four attributes (variables). The two alternatives are local airlines in Taiwan that services the intercity route of Taipei to Tainan. In this paper, we used the code A and B to represent these two airlines. The four attributes were flight frequency, ticket price, ages of airplane and consumer's recommendation to airline services. Each of the four attributes had three levels. The detail definition of these attributes and their levels are listed in Table 2. The values of all levels referred the airline market presence of the intercity route of Taipei to Tainan and the statistics of airline fleets.

Since most passengers rarely know the information of ages of airplane, airline management will not publish that information actively to its passengers as well. Therefore, we assumed that travelers possessed the incomplete information of ages of airplane in one of the two airline alternatives. By the way, consumer's recommendation used here was to be viewed as the external signaling. It was assumed in this study that passengers would refer the consumer's recommendation when they faced a situation of incomplete information on the attribute of ages of airplane. Hence, if one alternative missed the information of airplane ages, the information of consumer's recommendation would be shown. On the contrary, if one alternative with complete information of ages of airplane, the information of consumer's recommendation would not be shown.

The stated choice experiment contained two choice scenarios and each scenario with two choice games. Therefore, it could be reached four choice responses from each one respondent. Of those two scenarios, Scenario I didn't provide the information of ages of airplane of one alternative, for example, airline A, and missed the information of consumer's recommendation of the other alternative, airline B. Scenario II presented the complete information of all attributes to passengers. Table 3 was one example of our stated choice experiment.

Table 2. Attributes And Their Levels of Stated Choice Experiment

Attributes	Levels
Flight frequency	(1) less than 1 flight per hour; (2) 2 to 3 flights per hour; (3) more than 4 flights per hour
Ticket price	(1) $NT 1400; (2) $NT 1575; (3) $NT 1750
Ages of airplane	(1) less than 4 years; (2) 5 to 9 years; (3) more than 10 years
Consumer's recommendation	(1) fine; (2) good; (3) excellent

According to Table 3, in Scenario I, ages of airplane as well as consumer's recommendation were unique attributes to passengers, as they were unknown in one of the two alternatives, but not simultaneously. Hence, passengers might have to use the rest common attributes for supporting to make the choice decision. In the matter of Scenario II, passengers could make their choice decision based on the complete information of all attributes. The outcome of their decisions could be compared with the decisions in Scenario I, and then the effects of incomplete travel information on passengers' choice could be further analyzed.

Table 3. An Example of Stated Choice Experiment Used in This Study

	Scenario I	
	☐ *Airline A*	☐ *Airline B*
Flight frequency	< 1 flight/hr.	2 ~ 3 flights/hr.
Ages of airplane	(Information unavailable)	5 ~ 10 years
Ticket price	$NT 1750	$NT 1575
Consumer's recommendation	Good	(Information unavailable)
	Scenario II	
	☐ *Airline A*	☐ *Airline B*
Flight frequency	< 1 flight/hr.	2 ~ 3 flights/hr.
Ages of airplane	> 10 years	5 ~ 10 years
Ticket price	$NT 1750	$NT 1575
Consumer's recommendation	Good	Fine

3.2 Utility Specification

In our study, we used logit model to fit the choice data from stated choice experiment described above. In order to explore the effects of incomplete travel information on passengers' choice behavior, the variables with incomplete information needed to be measured. Here we developed three types of specification of those variables.

Firstly, we used an indicator variable to indicate that whether the information of the k^{th} variable is available or not. That is to say,

$$I_{ki} = \begin{cases} 1, \text{if the information of the } k^{th} \text{ variable of alternative } i \text{ is available;} \\ 0, \text{otherwise.} \end{cases} \tag{1}$$

If we placed the indicator variable into the utility function and multiplied with the k^{th} variable, which the information might be available or unavailable, then we could get the utility function like as follow:

$$V_i = \alpha_i + \beta_1 X_{1i} + \beta_2 X_{2i} + \ldots + [\beta_k \cdot I_{ki} \cdot X_{ki} + \beta'_k \cdot (1 - I_{ki})] + \ldots + \gamma Y \tag{2}$$

In equation (2), $X_{ji}\ (\forall j \neq k)$ is the variable with certainly information in alternative *i*; X_{ki} is the variable with uncertain information, i.e. the information might be available or unavailable for respondents; *Y* represents the vector of socio-economic variable. Thusly, if the information of the k^{th} variable of alternative *i* is unknown, then $I_{ki} \cdot X_{ki}$=0 and the parameter of β'_k will be estimated. However, if the k^{th} variable of alternative *i* is provided with complete information, then $I_{ki} \cdot X_{ki} \neq 0$ and β_k will be estimated. The effect of β'_k is expected to be negative on passenger's choice decision that implies that passenger doesn't like to make choice decision under the scenario of incomplete information. The result of estimation based on Equation (2) was called as DUM model.

Secondly, similar to Equation (2), but it assumes that there is an interact relationship between the socio-economic backgrounds of passengers and the indicator variable of incomplete information. Because we thought that there is a different choice behavior between different backgrounds of passengers, especially when they face a choice scenario with incomplete information. That is to say, the dummy variable, $(1 - I_{ki})$, in the Equation (2) is replaced with the interaction between socio-economic variables and the dummy variable, i.e. $(1 - I_{ki}) \cdot Y$. Hence, the specification of utility function can be shown as the following equation:

$$V_i = \alpha_i + \beta_1 X_{1i} + \beta_2 X_{2i} + \ldots + [\beta_k \cdot I_{ki} \cdot X_{ki} + \beta'_k \cdot (1 - I_{ki}) \cdot Y] + \ldots \tag{3}$$

Follow the Equation (3), it could further analyze the impacts of the socio-economic attributes (i.e. *Y*) of respondents interacted with the condition of incomplete information on the choice decision. This was called as DUM-SC model.

Thirdly, it could specify the parameter of the k^{th} variable into random parameter. In other words, there might be taste variances between individual respondents. Therefore, under the specific probability distribution, for example, the normal distribution, it could specify the conditional utility function as follows:

$$V_{i|\sigma_{kt}} = \alpha_i + \beta_1 X_{1i} + \beta_2 X_{2i} + \ldots + (\beta_k + \sigma_{kt}) \cdot X_{kit} + \ldots + \gamma Y \tag{4}$$

In equation (4), where σ_{kt} denotes the standard deviation of the respondent t to the evaluation of the k^{th} variable, which the information might be unavailable. It can apply the mixed logit model to estimate Equation (4). The result could be called as RCL model.

3.3 Data Collection

Data for empirical study were collected through questionnaire survey. The respondents who were going to Taipei by airplane were randomly selected at the Tainan Airport and invited to participate in our survey. To ensure the validity of questionnaire survey, each respondent had to complete three sections of questions. Section I contained questions about their trip experiences, Section II presented the two choice scenarios of stated choice experiment, and each with two choice games, finally, Section III included questions about socio-economics of respondents. Among 520 passengers surveyed, 418 usable survey forms were collected.

4. RESULTS AND DISCUSSIONS

4.1 Sample Descriptions

The backgrounds of our sampled passengers can be summarized as follows:

1. There were half-and-half passengers that took the flight trip for business purpose and non-business purpose.

2. Most passengers, around 60%, bought their ticket at the airport ticket counter. The usage of Internet ticketing was nearly 25%.

3. The number of male sampled passengers was 234 persons, which dominated around 55% of total respondents. 40% of all passengers were below age 30 and 38% were 31 to 40 years old. Also, near 90% of passengers were above college educated. Personal monthly income of approximately 33% was below $NT 35 thousand and 30% was in the range of $NT 35 thousand to $NT 50 thousand.

4. The primary top five factors that influenced passengers' choice of airlines were 'Convenient flight schedules', 'Safety performance', 'On-time performance', 'Corporate image', 'Convenient ticketing channels' and 'Ticket price'.

4.2 Estimation Results

In this study, binary logit model was used and maximum likelihood estimation was applied. The attribute levels were orthogonally coded to catch the possible non-linear effects between attributes levels. This implies that for any attribute with K levels, K-1 indicator variables are constructed. Since all selected attributes in this study had three levels, two indicator variables were used for each attribute, as illustrated in Table 4. The first indicator is used to capture the linear effects of the attributes, while the second one is used to capture any quadratic effects.

Using this orthogonal coding scheme, a binary logit model was estimated. In that model, it assumed that the values of the variables with incomplete information, i.e. 'Ages of airplane' of Airline A as well as 'Consumer's recommendation' of Airline B, were replaced with zero. By the way, there were 41 samples eliminated from 418 sampled passengers because their choice responses were obviously unreasonable. Thus, there were total 1508 (i.e. 377×4) observations for model estimation.

Table 4. The Orthogonal Coding Scheme

	Indicator 1	Indicator 2
Attribute level 1	–1	1
Attribute level 2	0	–2
Attribute level 3	1	1

At first, we used those 1508 observations to estimate a binary logit model. Of that, the values of 'Ages of airplane' and 'Consumer's recommendation' were assigned to be 0 under incomplete information. This model could be viewed as a base model and could be compared with other models, which were based on the different types of utility specification, i.e. equation (2), equation (3) and equation (4). Table 5 presents the parameter estimates, their asymptotic t-statistics and relative importance of base model. The relative importance of all attributes was computed in percentage terms to reflect their weighted importance by the following equation (Hu and Hiemstra, 1996):

$$W_j = \frac{Max(v_{ij}) - Min(v_{ij})}{\sum_{j=1}^{J} Max(v_{ij}) - Min(v_{ij})} \times 100\% \quad (5)$$

where

W_j = relative importance of attribute j (j=1, J)

$Max(v_{ij})$ = maximum level i's utility in attribute j, and

$Min(v_{ij})$ = minimum level i''s utility in attribute j.

In Table 5, there was no socio-economic variable, such as income or gender, because they had been proved insignificantly through the estimation. It couldn't imply that the socio-economic variables were not important; actually, income or gender generally is an obvious impact factor on travelers' mode choice behavior. The reason of that should be the choice alternatives we discussed in this study were the same transportation mode – airline, the level of services of these alternatives were not so different that the impacts of socio-economic variables, especially income, were not shown significant.

From the result of Table 5, all variables, no matter linear terms or quadratic terms, were significant at the level (α) of 0.1; also the fitness of this model was good. Of those variables in the model, 'Service quality' and 'Airline image' were used to measure the impacts of perceived service quality as well as image on passengers' choice under the situation of uncertainty choice decision. The estimated results of these two variables were significant and the affecting effect of 'Airline image' was greater than that of 'Service quality'. It implied that passengers might emphasize on the image of airlines when making a decision to reduce the risk of uncertainty that was raised by incomplete travel information.

Table 5. Estimation Results of The Base Logit Model

		Parameter Estimates	*Asymptotic t-Statistics*	*Importance (Percentage)*
Constant		0.2671	3.129	
Flight frequency	L	0.2069	5.353	17.1
	Q	-0.0714	-2.653	
Ages of airplane	L	-0.5234	-9.605	42.5
	Q	-0.0988	-3.397	
Ticket price	L	-0.1747	-3.580	14.2
	Q	-0.0443	-1.730	
Consumer's Recommendation	L	0.3220	7.371	26.2
	Q	-0.0534	-1.788	
Service quality		0.1654	2.637	
Airline image		0.3413	6.301	
LL(0)		-1045.2659		
LL(B)		-906.3412		
Rho Square		0.1329		
# Observations		1508		

"L" and "Q" are appropriately coded linear and quadratic.

According to the estimated results of all linear terms and quadratic terms of the four manipulated attributes, we could further calculate the relative importance of these variables by use of the equation (5). The figures in Table 5 shown that 'Ages of airplane' were the most important attribute compared with other attributes, while 'Consumer's recommendation' dominated the second place of relative importance. The outcome was not very similar to the results of passed studies, i.e. Kivetz and Simonson (2000); Lu and Chiang (2004), that respondents would weigh more importance on the attributes, of which the information were available in all alternatives. One possible explanation might be that airline passengers originally emphasize on the information of flight safety that is seldom available for passengers, however. Hence, when the information of flight safety in terms of 'Ages of airplane' in this paper and was shown in the stated choice scenarios, passengers would place more weights of that attribute on their choice responses naturally, even in Airline A, the information of 'Ages of airplane' was unavailable.

In the matter of 'Consumer's recommendation', the importance just followed behind the attribute of 'Ages of airplane', it might be an external signal for passengers while facing incomplete information. Therefore, the importance of that attribute just followed behind the attribute of 'Ages of airplane'.

'Ticket price' dominated the last ranked important attribute because it is no longer the only factor that passenger emphasized in the local market of Taiwan air transportation, which has introduced the service competitive strategy several years ago. Of course, the other reason of that might be the oligopoly characteristic of Taipei-to-Tainan air transportation market; the variety of ticket price is limited.

Table 6, DUM A and DUM B, are the estimated results based on the utility specification of Equation (2). In Table 6, 'Indicator – Ages of airplane' was used to indicate that whether the information of ages of airplane was available or not, and 'Indicator – consumer's recommendation' was similar to that. One can refer Equation (1) for further detailed specification of these two indicator variables.

From Table 6, it can clearly be seen that all variables, except two indicator variables, were significant in DUM A as well as DUM B. While comparing with the result of the base model, listed in Table 5, it also can be found that the coefficients of the four manipulated attributes as well as of the two external signal variables, i.e. service quality and airline image, in Table 6 were almost the same with the result in Table 5. It implied that the estimations of those variables might be consistency and robustness. That is to say, the impact of 'Airline image' still was greater than another external signal variable, 'Service quality', on passengers' choice under incomplete information scenario. Moreover, the 'Ages of airplane' still dominated the most important attribute as well as 'Consumer's recommendation' followed behind. The third important attribute was then the ' Flight frequency' and the last ranked important attribute was 'Ticket price'.

Table 6. Estimation Results of The Logit Model – DUM model

		DUM A		*DUM B*	
		Parameter Estimates	*Asymptotic t-Statistics*	*Parameter Estimates*	*Asymptotic t-Statistics*
Constant		0.1898	1.831	0.2701	2.806
Flight frequency	L	0.2084	4.800	0.2068	5.794
	Q	-0.0713	-2.651	-0.0714	-2.739
Ages of airplane	L	-0.5250	-9.903	-0.5234	-10.186
	Q	-0.0976	-3.367	-0.0988	-3.358
Ticket price	L	-0.1758	-4.447	-0.1747	-3.955
	Q	-0.0439	-1.625	-0.0444	-1.522
Consumer's recommendation	L	0.3180	7.376	0.3222	7.031
	Q	-0.0497	-1.690	-0.0535	-2.011
Service quality		0.1656	2.615	0.1653	2.760
Airline image		0.3421	6.217	0.3414	6.056
(1-Indicator of Ages of airplane)*		-0.1460	-1.380		
(1-Indicator of Consumer's recommendation)†				-0.0022	-0.070
LL(0)		-1045.2659		-1045.2659	
LL(B)		-905.5208		-906.3397	
Rho Square		0.1337		0.1329	
# Observations		1508		1508	

"L" and "Q" are appropriately coded linear and quadratic.

*: Alternative specification variable for Airline A. If ages of airplane of Airline A is unavailable, then the value of (1-Indicator of Ages of airplane) is 1; otherwise, it is 0.

†: Alternative specification variable for Airline B. If consumer's recommendation of Airline B is unavailable, then the value of (1-Indicator of Consumer's recommendation) is 1; otherwise, it is 0.

The estimations of the two dummy variables were not much significant. Especially the 'Indicator-Consumer's recommendation', the t-statistics of it even was less than 1, though the estimated results illustrated that there were truly negative impacts of incomplete travel information on passengers' choice. Furthermore, we applied the likelihood ratio test to exam whether the differences between these two models, i.e. DUM A as well as DUM B in Table 6, and the base model listed in Table5 was significant or not. The χ^2 statistics (i.e. 1.641 and 0.003, respectively) shown that no matter DUM A or DUM B didn't improve the performance significantly, compared with the base model, after considered additional indicator variable to catch the effect of unknown information on passenger's choice behavior.

Table 7 was the result that we further considered the impacts of passengers' socio-economic backgrounds and interacted with the scenario of incomplete travel information. It also showed that all variables in the model were quite significant at the level of 0.1, except the quadratic term of 'Ages' of airplane', which the t-statistics showed a little bit less significant. By the way, the goodness of fit, indicated by Rho-Square, was also not bad (0.14).

Table 7. Estimation Results of The Logit Model – DUM-SC model

		DUM-SC	
		Parameter Estimates	*Asymptotic t-Statistics*
Constant		0.1897	1.905
Flight frequency	L	0.2108	5.768
	Q	-0.0695	-2.614
Ages of airplane	L	0.3143	6.645
	Q	-0.0478	-1.585
Ticket price	L	-0.1778	-4.181
	Q	-0.0439	-1.682
Consumer's Recommendation	L	-0.5267	-9.738
	Q	-0.0992	-3.743
Service quality		0.1640	2.806
Airline image		0.3397	5.999
(1- Indicator of Ages of airplane) × Income*		-0.1232	-2.280
(1- Indicator of Consumer's recommendation) × Education†		-0.1620	-2.896
LL(0)		-1045.2659	
LL(B)		-902.6405	
Rho Square		0.1364	
# Observations		1508	

"L" and "Q" are appropriately coded linear and quadratic.

*: Alternative specification variable for Airline A. If ages of airplane of Airline A is unavailable, then the value of (1-Indicator of Ages of airplane) is 1; otherwise, it is 0.

†: Alternative specification variable for Airline B. If consumer's recommendation of Airline B is unavailable, then the value of (1-Indicator of Consumer's recommendation) is 1; otherwise, it is 0.

The magnitudes of the four attributes demonstrated that 'Ages of airplane' also was the most important factor and 'Consumer's recommendation' dominated the second place of importance. The results also described that passengers would put more emphasis on flight safety, which was in terms of the ages of airplane here, and word-of-mouth of consumers into their decisions. However, passengers did not easily acquire that information, especially the ages of airplane. Moreover, of the two external signal variables, passengers also preferred 'Airline image' to 'Service quality' to support their choice behavior under incomplete travel information.

In Table 7, we used the terms '(1-Indicator of Ages of airplane) × Income' and '(1-Indicator of Consumer's recommendation) × Education' to catch the perceived impacts of incomplete information by passengers' backgrounds. The outcomes implied that there were negative effects of incomplete information on passengers' choice. Also, the higher income a passenger had, the more significant negative impact of incomplete information of ages of airline on the choice decision was; the more education the passenger received, the more significant effect of incomplete information of consumer's recommendation on the decision was. It might be reasonable that higher income passengers may have the propensity of risk averse; hence, they may dislike making decisions under the uncertainty travel information. Meanwhile, higher educated passengers may concern the word-of-mouth, i.e. consumer's recommendation, more to airlines. While comparing the coefficients of those two interaction terms, it was found that the term '(1-Indicator of Consumer's recommendation) × Education' got larger negative effect on utility than the term '(1-Indicator of Ages of airplane) × Income' did. As a result, passengers' education played more important role on influencing passengers' choice decisions under incomplete information.

By use of the Likelihood ratio test, we could further exam whether the performance of DUM-SC, based on the utility specification of Equation (3), was better than the base model (i.e. Table 5). The χ^2 statistics is 7.401, which is greater than the critical value of 4.6052 at the α-level 0.1 and 2 degrees of freedom, implies that the performance of DUM-SC was better than the base model. In other words, after considering the impacts of passengers' backgrounds, it would perform a better fit to analyze the choice behavior under the scenario of incomplete information.

Finally, we specified the parameters of those variables with incomplete information as random parameters into choice model and further estimate that model by the application of mixed logit model. Table 8 illustrated the estimated results. It can observed that, from Table 8, most variables were significant at the α-level 0.1, except the variable that represented the standard deviation (i.e. σ) of the linear term of 'Ages of airplane', which the t-statistics was only around 0.1.

However, there was obvious one point different to the results of those previous models obviously. It can be observed that the importance of 'Flight frequency' as well as of 'Ticket price', which information was available in all alternatives (i.e. common attributes), were more than that of 'Ages of airplane' and 'Consumer's recommendation'. These results were quite similar to the findings of previous studies, that is, passengers weighed more values on the common attributes than on unique attributes, which the information was acquired only in partly alternatives. The reason led to these findings were that we specified two random parameters, the linear term of 'Ages of airplane' and of 'Consumer's recommendation', into utility function for measuring the taste variances between individual passengers.

Although the estimated results of 'σ (Ages of airplane)' and 'σ (Consumer's recommendation)' showed less significant, especially the t-statistics of the former one was only 0.104. These meant that passengers' evaluations of 'Ages of airplane' under incomplete information might not significantly have the taste variances between individuals. In contrast to 'Consumer's recommendation', the significance of 'σ (Consumer's recommendation)' was much higher implied that there might be taste variances between individual passengers when they evaluated the effect of incomplete information of 'Consumer's recommendation' on their choice behavior. That is to say, we could segment the effect of ‘Consumer’s recommendation’ with incomplete information into several parts by passengers’ backgrounds, for example, passengers’ education. That might respond to the estimated result in Table 7 that the interaction term of ‘(1 – Indicator of Consumer’s recommendation) × Education’ got higher significance impact on passengers’ choice.

However, after using the Likelihood ratio test to exam whether the performance of RCL was better than the base model or not, it is found that there was no significant difference between these two models. It indicated that the specification of random parameter of RCL didn’t improve the performance significantly.

Table 8. Estimation Results of The Logit Model – RCL model

		RCL		
		Parameter Estimates	*Asymptotic t-Statistic*	*Importance (Percentage)*
Constant		0.2829	3.202	
Flight frequency	L	0.2117	5.621	33.1
	Q	-0.0749	-2.752	
Ages of airplane	L	0.0083	5.200	13.6
	Q	-0.0572	-1.993	
Ticket price	L	-0.1829	-4.834	27.7
	Q	-0.0413	-1.522	
Consumer’s Recommendation	L	-0.0148	-7.803	25.6
	Q	-0.1076	-3.798	
Service quality		0.1677	2.820	
Airline image		0.3511	6.885	
σ (Ages of airplane)	L	0.0024	0.104	
σ (Consumer’s recommendation)	L	0.0924	1.573	
LL(0)		-1045.2659		
LL(B)		-904.6703		
Rho Square		0.1345		
# Observations		1508		

5. CONCLUSIONS AND SUGGESTIONS

5.1 Conclusions

This paper discussed a practical issue that does generally exist in our daily life, that is, information asymmetry. We especially focused on the impact of incomplete information that buyers always possessed on their choice behavior in air transportation market. Through empirical analysis, it concludes some significant findings as following:

1. The safety performance of airlines truly influences passengers’ choice behavior, this

could be observed from the estimated result of 'Ages of airplane' and its importance. By the way, 'Consumer's recommendation', i.e. word-of-mouth, also was the important factor affecting passengers' choice. But these results were not similar to the findings of passed studies that showed consumers would overweigh the importance of common attributes, which information is available in all alternatives. However, in the random parameter logit model, the magnitudes of importance of the unique attributes, i.e. 'Ages of airplane' and 'Consumer's recommendation', were less than those of 'Flight frequency' as well as of 'Ticket price'. It indicated that passengers' evaluations of the impacts of the two incomplete information variables might have taste variances. Thus, it should consider the taste variances between individuals into the choice scenario of incomplete information so that it might show the relative importance between common attributes and unique attributes properly.

2. Passengers might rely on the information of external signals to support their decision under incomplete information. In this paper, it used two variables to measure the effect of those external signals, that is, 'Service quality' and 'Airline image'. The findings implied that passengers would rely more external information on 'Airline image' than on 'Service quality'. This result also indicated that consumers' word-of-mouth played an important role on passengers' choice behavior.

3. The best model of this study was DUM-SC that considered the effects of interaction between passengers' socio-economic backgrounds and incomplete information into utility function. The outcome showed that there were negative impacts of incomplete information on passengers' choice and higher income passengers would perceive higher negative impact of incomplete information and higher educated passengers would perceive much higher negative effect of incomplete travel information. By the way, through the results of DUM-SC, we also found that the socio-economic variables, such as income or gender, were not significant when they considered as independent explanatory variables into the base choice model, but they did affect passengers' choice by specific types of interaction with incomplete travel information. This is the further contribution of model DUM-SC.

5.2 Suggestions

There were some limitations of this study, especially the stated choice design that assigned Airline A with incomplete information of 'Ages of airline' and Airline B with the incomplete information of 'Consumer's recommendation'. Therefore, it could not put the effects of these two variables together into one choice model by use of the dummy variables. This may be improved in the future study.

Although DUM-SC showed that income and education of passengers were significant variables when they considered as interaction types with incomplete information. It still not caught the effects of different age groups of passengers on the choice decision under incomplete information. Unfortunately, in this study, the distribution of ages of respondents was not so average that there were insufficient samples, especially the samples over age 40, could be used to analyze the impacts on choice behavior under incomplete information. This may overcome in the future study by getting more representative samples.

Measuring the impacts of incomplete travel information on passengers' choice is difficult.

This study used three different kinds of utility specifications to analyze those effects but the estimated results, except DUM-SC, were not much better than the base model. However, this paper gave some hints for practical research to achieve a better understanding of the impacts of incomplete information on travelers' choice behavior in the future.

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